"Version with Markings to show Changes Made"

1. (Amended) Imaging [and/]or raster-mode scanning apparatus, [in particular scanning microscope], having

a compensation device for compensating for ambient influences that may degrade the imaging, comprising:

[- an image acquisition device (7) for acquiring at least one pixel of an object, and

- an image processing device (2) which is connected downstream of the image acquisition device, and also an image display device, furthermore at least]

- an electrical filter (5), and

- at least one sensor (4) for providing [picking up]

a first signal dependent on the ambient influences [and

- an actuator and/or a control element (3),]

characterized in that the first signal [dependent on the ambient influences],

- passes through the filter directly and

- drives an internal actuator or a internal control elements (3a, 3b) of the apparatus [the actuator and/or a control element (3)]

which has an effect on the imaging [and/]or on the image display, in a calibrated state of the apparatus, which

comprises [is characterized by] where?

- a [the] setting of a [the] transfer characteristic of the filter, image degradations are greatly reduced or essentially compensated for,

and in that

the filter (5), for calibrating the apparatus, has

- a calibration input and

- a second signal is applied to the calibration input of the filter.

2. (Amended) Apparatus according to claim 1, characterized in that

the [apparatus comprises] at least one sensor (4) is adapted for detecting at least one physical quantity outside the apparatus, and for [this sensor] outputting the first signal which depends on the ambient influences at the location of the sensor.

3. (Amended) Apparatus according to claim 2, characterized in that the sensor (5) comprises at least one pick-up for electromagnetic [and/]or magnetic fields [and/]or air vibrations [and/]or ground vibrations.

4. (Amended) Apparatus according to claim 1, characterized in that the filter (4) comprises a signal input which is connected to an output of an image processing device (2) which is connected upstream with an image acquisition device (7) for acquiring at least one pixel of an object, and also an image display device [the signal input of the filter (5) is connected to an output of the image processing device (2)].

5. (Amended twice) Apparatus according to claim 1, characterized in that the apparatus comprises a device for [the] manually calibrating [calibration of] the filter.

6. (Amended twice) Apparatus according to claim 1, characterized in that the control element (3) is arranged in the image processing device (2) [and at least part of the image degradation is reduced or compensated for in the image processing device.]

7. Apparatus according to claim 1, characterized in that the actuator (3) is assigned to the scanning device.

8. (Amended twice) Apparatus according to claim [1] 4, characterized in that an output of the image processing device (2) is connected to the calibration input of the filter (5).

9. (Amended twice) Apparatus according to claim 1, characterized in that the second signal varies as a function of scanning position of a scanning device of the apparatus (1) [and/]or of time.

10. (Amended twice) Apparatus according to claim 2, characterized in that the apparatus is for operation in a calibration mode and subsequently operable in an image mode, whereby, in the calibration mode, ambient influences which degrade the image are detected by the comparison of an image of a predetermined reference object with an image of the real structure in the image processing device (2) [the imaging of a predetermined reference object and comparison of the image with the real structure of the reference object in the image processing device], and are greatly reduced or essentially compensated for by calibration of the filter, and whereby [the] image defects are compensated for by maintaining the calibration in the image mode, even in the event of a change in the ambient influences.

image - where come from ??

11. (Amended) Apparatus according to claim 10, characterized in that in the calibration mode:

- a scanning device scans a selected section of a [the] reference object,

- the [digital] image processing device (2) compares a stored signal assigned to the reference object with [the] a real image signal of the reference object, the [said] real image signal having been obtained from the image acquisition device (7), and whereby in the image processing device a defect signal is formed which is assigned to a difference resulting from the comparison between the stored and the real signal and which the image processing device outputs to the filter (5) [and forms a defect signal assigned to the difference and outputs it to the filter (5)], and

- the apparatus stores, in a memory, data for generating the second signal for setting the transfer parameters of the filter for the image mode.

12. (Amended) Apparatus according to claim 10, characterized in that in the image mode:

- a scanning device scans an [the] object to be imaged, and

- the apparatus, taking the data stored during the calibration mode as a [the] basis, generates the second signal for defining the transfer parameters of the filter.

13. (Amended twice) Apparatus according to claim 2, characterized in that the apparatus is set up for automatically calibrating the filter during an [the] image mode.

14. Apparatus according to claim 13, characterized in that the image acquisition device (7) scans the object to be imaged and the image processing device (2) is set up for determining the displacement of the line centroids of successive image lines within the whole image and outputs the second signal as a function of this temporal displacement to the filter (5).

15. (Amended) Apparatus according to claim 13, characterized in that the image processing device (2) is set up for determining a [the] temporal displacement of the image centroid of successive images and outputs the second signal as a function of this temporal displacement to the filter (2).

16. (Amended twice) Apparatus according to claim 13, characterized in that the filter is set up for carrying out a [the] cross-correlation of the first signal and of the second signal.

17. Apparatus according to claim 1, characterized in that the apparatus is set up for reducing or compensating for the image degradation in two mutually orthogonal directions.

18. Apparatus according to claim 1, characterized in that the apparatus comprises a scanning electron microscope, a force microscope, a surface roughness measuring instrument, an

optical scanning microscope, a light microscope, a transmission electron microscope or a lithography installation.

19. (Amended) Apparatus according to claim 18, characterized in that, in the case of the electron microscope, an [the] actuator (3) comprises a device for deflecting a [the] electron beam and/or a device for displacing the sample.

20. (Amended) Apparatus according to claim 18, characterized in that, in the case of the light microscope, the actuator (3) comprises a device for deflecting [the] light and/or a device for displacing a [the] sample.

21. (Amended twice) Apparatus according to claim [4] 15, characterized in that the apparatus is a light microscope or a transmission electron microscope, wherein the first signal, as the second signal, is also [being] determined on the basis of [from] the temporal displacement that is determined.

22. (Amended twice) Method for operating an imaging [and/]or raster-mode scanning apparatus for compensating for ambient influences that may degrade the imaging[, in particular for operating an apparatus according to claim 21], comprising the steps of

- providing a first signal [a first signal] dependent on the ambient influences
- passing the first signal [is passed] directly through an electrical filter (5),
- providing an [and the] output signal of the filter
- driving [drives] an internal actuator [and/]or an internal control element (3a, 3b) of the apparatus [(3)] with the output signal, which has an effect on the imaging and/or the image display, whereby, in the calibrated state of the apparatus, which is effected by

what image?

setting the transfer characteristic of the filter, the image degradation is greatly reduced or essentially compensated for, and the calibration of the apparatus is carried out by a [the]

same filter?

setting of a [the] filter (5) by a second signal being applied to a [the] calibration input of the filter.

23. Method according to claim 22, characterized in that the calibration of the apparatus is carried out by manual setting of the filter (5).

24. Method according to claim 22, characterized in that a control element (3) in the image processing device (2) is driven and the compensation of the image degradation is carried out at least partially in the image processing device.

25. Method according to claim 22, characterized in that an actuator (3) in the scanning apparatus is driven and the compensation of the image degradation is carried out at least partially by driving the actuator (3) of the scanning apparatus.

26. (Amended) Method according to claim 22, characterized in that the apparatus is operated in a calibration mode and subsequently in an image mode, whereby

- ambient influences that degrade the imaging are detected by means of a sensor (4) which is arranged outside the apparatus and drives a [the] signal input of the [a] filter (5),
- in the calibration mode, the degradation of the image is greatly reduced or essentially compensated for by an [the] imaging of a predetermined reference object and comparison of the image of the reference object with a [the] real structure of the reference object and by calibration of the transfer characteristic of the filter, and
- in the image mode, the degradation of the image is at least partially compensated for by maintaining the calibration, even in the event of a change in the ambient influences.

27. (Amended) Method according to claim 26, characterized in that the calibration mode comprises at least the following steps:

- determination of the [a] first signal which depends on an [the] interfering influence at the location of the sensor, by the [a] sensor (4[5]) arranged outside the apparatus;

- application of the first signal to the signal input of the filter;

- acquisition of a selected section (9) of the [a] predetermined reference object by means of an image acquisition device (7) by the scanning of the reference object;

- comparison of the acquired [image] selected section (9) with the real structure of the reference object; and

- determination of a defect signal assigned to a [the] difference which results from the comparison;

- application of the second signal, derived from the defect signal, to the regulating input of the filter (5) for defining the characteristic of the filter;

- application of the output signal of the filter to the signal input of the regulating amplifier (6)

- application of the output signal of the regulating amplifier to an actuator [and/]or a control element (3) for the purpose of correcting the degraded [reduced] image quality;

- iterative calibration of the characteristic of the filter, in such a way that the reduction of the imaging quality is greatly reduced or essentially compensated for, by means of the following steps:

- comparison of the corrected image with the real structure of the reference object

- alteration of the characteristic of the filter in such a way that the corrected image approximates to the real structure of the reference object

- storage of data determined by the iterative calibration for providing [generating] the transfer [determined] characteristic of the filter for the image mode.

28. (Amended) Method according to claim 26, characterized in that, in the image mode, a sample is acquired by scanning, the characteristic of the filter of the apparatus that has been determined in the calibration mode being fixedly prescribed, and the output signal of the [digital] filter (5) which is a digital filter, after passing through a regulating amplifier (6), is assigned to the actuator [and/]or the control element (3), with the result that image defects are greatly reduced or essentially compensated for even in the event of a change in the ambient influences.

29. (Amended) Method according to claim 22, characterized in that

- ambient influences which impair the imaging are detected by means of the [a] sensor (3), which is arranged outside the apparatus and drives the signal input of the [a digital] filter (5) which is a digital filter, with the [a] first signal,

- an image acquisition device (7) feeds an image processing device (2), in which an image analysis is carried out and a signal dependent on the analysis is applied as the second signal to the calibration input of the filter (5),

- the output of the filter (5) is applied via a regulating amplifier (6) to the [an] actuator [and/]or the [a] control element (3) of the apparatus, which has an effect on the image, the image degradation thereby being greatly reduced or essentially compensated for.

30. (Amended) Method according to claim 31, characterized in that

- an [the] object to be imaged is scanned by the image acquisition device (7),

- the image analysis comprises a [the] recursive determination of a [the] displacement of [the] line centroids of successive image lines within the whole image, and

- the second signal is calculated from the temporal displacement, which is a temporal displacement.

31. (Amended) Method according to claim 29, characterized in that

- the image analysis comprises a [the] recursive determination of a [the] displacement of [the] image centroid of successive images, and

- the second signal is calculated from the [this] temporal displacement, which is a temporal displacement.

32. (Amended twice) Method according to claim 30, characterized in that essentially a [the] cross-correlation of the first signal with the second signal is carried out in the filter (5) and, consequently, the actuator or the control element (3) is fed with a drive signal which is dependent on the cross-correlation between the first signal and second signal.

33. (Amended twice) Method according to claims 22 [21], characterized in that

- feeding an image processing device (2) with an image signal of an image acquisition device (7) [an image acquisition device feeds (7) an image processing device (2)],

- analyzing of the image signal in the image processing device (2), and [an analysis is carried out in the image processing device, and]

- applying a signal dependent on the result of the analyzing step as the first signal to a signal input of the filter, and [a signal dependent on the analysis is applied as the first signal to **a** the signal input of the filter, and]

- applying a signal dependent on the result of the analyzing step as the second signal to a signal input of the filter, and [a signal dependent on the analysis is applied as the second signal to the calibration input of the filter,]

- applying the output of the filter (5) [is applied] via a regulating amplifier (6)to the [at least one] actuator [and/]or the [one] control element (3) of the apparatus, which has an

effect on the imaging, the imaging degradation thereby being greatly reduced or essentially compensated for.

34. (Amended) Method according to claim 33, characterized in that the analyzing of the image [analysis] comprises a [the] recursive determining [determination] of a [the] displacement of [the] line centroids of successive image lines within the whole image or the recursive determination of the displacement of the image centroid of successive images.

35. (Amended twice) Method according to claim 22, characterized in that the image degradation is essentially compensated for by means of the actuators [and/]or the control elements (3) acting in two mutually orthogonal directions.

36. (Amended) Apparatus for compensating for ambient influences in imaging and/or raster-mode scanning apparatuses that may degrade the imaging, comprising:

- a calibratable digital electrical filter (5);

- a regulating amplifier (6) which is electrically connected downstream of the filter,

characterized in that

- an internal actuator [and/]or an internal control element (3a, 3b) of the apparatus [(3)] is driven by the regulating amplifier, and that

[characterized in that]

a first signal dependent on the ambient influences can be passed via a [the] signal input of a [the] filter (5) through the latter, and a second signal is applied to a [the] calibration input of the filter, and

the <u>internally</u> driven actuator [and/]or the driven control element (<u>3a, 3b</u> [3]) has an effect on <u>an</u> [the] image, whereby, in <u>a</u> [the] calibrated state of the filter, the image degradation is greatly reduced or essentially compensated for.

37. Apparatus according to claim 36, characterized in that the apparatus comprises at least one sensor (4) for detecting at least one physical quantity outside the apparatus, this sensor outputting the first signal which is dependent on the ambient influences at the location of the sensor.

38. Apparatus according to claim 8, characterized in that the apparatus is designed for operation in a calibration mode and for subsequent operation in an image mode, whereby, in the calibration mode, ambient influences which degrade the image are detected by the imaging of a predetermined reference object and comparison of the image with the real structure of the reference object in the image processing device, and are greatly reduced or essentially compensated for by calibration of the filter, and whereby the image defects are compensated for by maintaining the calibration in the image mode, even in the event of a change in the ambient influences.

39. Apparatus according to claim 8, characterized in that the apparatus is set up for automatically calibrating the filter during the image mode.

40. Apparatus according to claim 8, characterized in that the apparatus is a light microscope or a transmission electron microscope, the first signal also being determined from the temporal displacement that is determined.

41. Apparatus according to claim 15, characterized in that the apparatus is a light microscope or a transmission electron microscope, the first signal also being determined from the temporal displacement that is determined.

Please add the following new claim 42:

42. Apparatus according to claim 4, characterized in that the apparatus is for operation in a calibration mode and subsequently operable in an image mode, whereby, in the calibration mode, ambient influences which degrade the image are detected by the comparison of an image of a predetermined reference object with an image of the real structure in the image processing device (2), and are greatly reduced or essentially compensated for by calibration of the filter, and whereby image defects are compensated for by maintaining the calibration in the image mode, even in the event of a change in the ambient influences.

Remarks

Specification Objections

An Abstract of the Disclosure has been adopted on a separate sheet as required by 37 CFR 1.72 (b).

The reference numeral 2 of Figs. 1a and 1d has been inserted into line 5 on page 11 and at various other positions of the following description.

The embodiments of figs 1c and 1d are described in the specification:

- by the amendments of the description on page 9, lines 29 to 33 and
- by the insertion of the description text of page 3 lines 21 to 28 into line 12 of page 10, and
- by inserting the term "corresponding to the block diagram of Fig. 1b" into line 7 on page 11 after the word Fig. 2, and
- by the insertion of the term "as shown in Fig. 1c arrow from box 3 to 2" into line 5 after the word external sensor on page 17, and
- by the insertion of the words "after Figure" into line 12 after the words "block diagram on page 20."

Additionally, it should be noted that in line 30 on page 18 reference is made to "Figure 1c" which has been omitted so far.

On page 11, the reference numerals 3a and 3b have been inserted into line 14 after the word "coils."

The numeral 16 has been inserted on page 19 into line 18 after the word "images."

Reference numeral 22 has been inserted into line 7 on page 19after the word "display."

Claim Objections

Claim 1 has been rewritten such that it fulfils the formalities under item 3 of the Office Action, the clarity requirements under item 5 of the Office Action, and the novelty requirements as well as those for an inventive step. The same is true for independent claims 22 and 33.

For revised claim 1, the features of "an image device (7)" and those of "an image processing device (2)" has been removed. These features are now part of revised claim 4. Moreover, for the sake of clarification the term "in particular scanning microscope" inline 2 of originally filed claim 1 has been cancelled. For the same purpose the term "is characterized by" in line 20 and 21 has been replaced by the word "comprises" whereby in the following the expressions "the setting of the transfer" has been replaced by "a setting of the transfer." The same applies for "the image" which reads now "an image."

Moreover, claim 1 comprises the additional features, being especially disclosed on page 4, lines 5 to 8 of the description, that one may use internal actuators and control elements.

Independent claim 22 has been revised such that now method steps are claimed. Furthermore, the restrictions quoted for new claim 1 has been inserted into claim 22 in a similar way. The same is valid for independent claim 36.

Claim 2 now refers to a concrete further development of "the at least one sensor (4)" defined in amended claim 1. Therein, the sensor (4) no longer "picks up" a first signal but "provides a first signal." Thus, the described conflict under item 5 of the Office Action is resolved.

Claim 4 has been rewritten and comprises not the former features of claim 1 with regard to "an image acquisition device (7)," "an image processing device (2)," and "an image display device" additionally to its original features.

Within claim 5 the wording "the manual calibration of the filter" has been replaced by the expression "manually calibrating the filter."

Regarding claim 6, the claim now depends on claim 4. Moreover, the wording "and at least part of the image decredation is reduced or compensated for in the image processing device" has been cancelled.

Regarding claim 8, the claim now depends on claim 4 instead of claim 1.

Regarding claim 9, the term "scanning device" has been replaces by the wording "a scanning device of the apparatus (1)."

Regarding claim 10, the claim now depends on claim 2. Furthermore, for clarification the wording "the image of a predetermined reference object and comparison of the image with the real structure of the reference object in the image processing device" has been replaced by the following "the comparison of an image of a predetermined reference object with an image of the real structure in the image processing device (2)." The amendment is explained and supported on page 4 last paragraph and on page 5 first paragraph. The term "the image" has been replaced by the word "image" in line 13 of claim 10.

Regarding claim 11, in line 3, the term "a reference object" is replaced by the wording the reference object. In line 5 of claim 11 the word digital has been cancelled. For the sake of clarification the wording "the image signal" has been replaced by the wording "a real image signal." For the same reason in line 7 of claim 2, the term "the reference object" is replaced by the expression "the real reference object." Moreover, inline 8 of the claim the word "said" has been removed. Additionally, for clarifying the claim the wording of lines 9 to 11 "and forms a defect signal sign to the difference and output it to the filter (5)" has been replaced by the wording "and whereby in the image processing device a defect signal is formed which is

assigned to a difference resulting from the comparison between the stored and the real signal and which the image processing device outputs to the filter (5)."

Regarding claim 12, in line 3 the wording "the object" has been replaced by the wording "an object", and in line 6 the term "the basis" is replaced by the term "a basis".

Regarding claim 13, in line 4 of the claim the term "the image" is replaced by the term "an image."

Regarding claim 15, in line 4 of the claim "the temporal displacement" is replaced by "a temporal displacement."

Regarding claim 16, in line 3 and 4 the term "the cross-correlation" is replaced by the wording "a cross-correlation."

Regarding claim 19, in line 4, the term "the electron beam" is replaced by the term "an electron beam". In line 5, the wording "the sample" is replaced by the term "a sample".

Regarding claim 20, in line 4 of the claim, the wording "the light" is substituted by the wording "light". Addditionally, in line 5 of the claim, the term "the sample" is replaced by the wording "a sample".

Regarding claim 21, for the sake of clarification, the wording "the first signal also being determined from the temporal displacement that is determined" has been replaced by the term "wherein first signal, as the second signal, is also determined on the basis of the temporal displacement." The expression "the temporal displacement" has remained unchanged since it has an antecedent basis in claim 15 via claim 13.

Regarding claim 22, the claims has been completely revised. The new claim 22 with amendments indicated can be seen from the attached new set of claims.

Regarding claim 22, the claim, as already discussed, has been completely revised. The new claim 22 with amendments indicated can be seen from the attached new set of claims.

Regarding claim 26, in lines 7 and 8, the term "the signal" is replaced by the term "signal", and in line 8, the term "a filter (5)" is replaced by the term "the filter (5)". Moreover, in line 11 of the claim the term "the imaging" has been replaced by the expression "an imaging". Moreover, into line 12 after the term "the image" the expression "of the reference object" has been inserted. Additionally, in line 13, the term "the real structure" has been replaced by the term "a real structure".

Regarding claim 27, in the 5, the term "a first signal" has been replaced by the term "the first signal", in line 6, the term "the interfering influence" is replaced by the term "an interfering influence", and in line 7, the term "a sensor (5)" is replaced by the term "the sensor (4)". Moreover, in line 11 and 12 of the claim, the term "a predetermined reference object" has been replaced by the term "the predetermined reference object". Moreover, in line 15 the word "image" has been replaced by the wording "selected section (9)". The expression "the real structure" has remained unchanged because it has its antecedent basis in claim 26. In line 18, after the word "difference" the expression "which results from the comparison" has been inserted. In line 27, the word "reduced" is replaced by the word "degraded" which has already been used in claim 26 in the same context. In line 40, after the wording "storage of data", the expression "determined by the iterative calibration" is inserted. Moreover, in the same line the word "generating" has been replaced by the word "providing", and also in line 40, the word "determined" has been cancelled.

Regarding claim 28, in line 7, the term "digital filter" is replaced by the wording "filter (5)", whereby after this word the expression "which is a digital filter" has been inserted.

Regarding claim 29, in line 4, "a sensor" has been replaced by "the sensor" in ine 6 "a digital filter" is replaced by "the filter", whereby after this word the expression "which is a digital filter" has been inserted. Moreover, in line 6 and 7 the term "a first signal" is replaced by "the first signal". Additionally, in line 14 and 15, the expression "an actuator and/or a control element has been replaced by the term "the actuator and/or the control element".

Regarding claim 30, in line 3, "the object" is replaced by "an object", in line 5 and 6 the term "the recursive determination of a displacement." Moreover, line 6, the wording "the line" is replaced by the wording "this" is replaced by the word "the" and in line 10, the wording "which is a temporal displacement" has been inserted.

Regarding claim 31, in line 3, "the recursive" is replaced by "a recursive". In line 4, "the displacement" is replaced by "a displacement", in line 6 the word "this" is replaced by the word "the" and in line 7, the expression "which is a temporal displacement" is inserted.

Regarding claim 32, in line 3, the term "the cross-correlation" is replaced by the term "a cross-sectional".

Regarding claim 34, the claim has been reformulated to conform with new claim 33. Thus, the wording "the image analysis comprises the recursive determination of the displacement of the line…" has been replaced by the wording "the analyzing of the image comprises a recursive determining of a displacement of line …"

Regarding claim 36, the amendments made on the claim are essentially the same as those changes made to claim 1.

New claim 42 is the same as claim 10, which depends on claim 2. Claim 42 depends on claim 4 and avoids multiple dependencies.

Claim Rejections Under 35 USC 112

With regard to the objections based under item 5 of the Office Action reference is made to the comments above which comprise the amendments for clarifying the claims.

Claim Rejections with Respect to Patentability

Novelty and Inventive Step of Claim 36 over "Mizuno et al."

Mizuno et al. discloses "a vibration of a body to be protected from the vibration" (claim 1, lines 1 to 3) of a common kind, which detects and especially applies forces from the outside of the vibration isolation body (1) (see e.g. claim 1 second to last line). Thus, it is described how visible disturbances of the isolation body (1) can be minimized indirectly.

On the contrary, the present invention, which refers to an "Apparatus for compensating for ambient influences in imaging or raster-mode scanning apparatus." Moreover, amended claim 36 comprises the amended feature in the following form:

characterized in that

-an internal actuator or an internal control element (3a, 3b) of the apparatus is driven by the regulating amplifier, and that

a first signal dependent on the ambient influences can be passed via a signal input of a filter (5) through the latter, and a second signal is applied to a calibration input of the filter, and

the internally driven actuator or the driven control element (3a, 3b) has an effect on an image, whereby, in a calibrated state of the filter, the image degradation is greatly reduced or essentially compensated for.

Whereby the latter feature is neither explicitly nor directly implicitly disclosed by "Mizuno et al." (Mizuno)

Thus, it is made clear that it is an object of the present invention that image defects due to external vibration are meant to be corrected by directly manipulating an internal actuator.

This problem is especially solved by the fact that the actuator and/or control element (3), namely the internal actuator or control element (3a, 3b) of the apparatus, is directly driven by the regulating amplifier.

There are no indications in the document of Mizuno or in any of the documents cited that would prompt a person skilled in the art to something that would fall into the terms of the subject matter of claim 36.

Therefore, amended claim 36 is clearly not anticipated nor had it been obvious for a person skilled in the art in the light of Mizuno at the time of Priority.

<u>Novelty and Inventive Step of Claim 1 over Masaki et al</u>

Although Masaki et al (Masaki) discloses "an active vibration resisting device of an electron microscope vibration" as similar to the present invention, the vibration isolation is done in a completely different way if compared to the invention in question. Insofar, the arguments stated in connection with Mizuno apply also for Masaki.

In particular, in order to emphasize this fact, claim 1 has been rewritten as follows:

characterized in that the first signal,

- passes through the filter directly and

- drives an internal actuator or a internal control elements (3a, 3b) of the apparatus

which has an effect on the imaging or on the image display, in a calibrated state of the apparatus, which

<u>comprises</u>

- a setting of a transfer characteristic of the filter, image degradations are greatly reduced or essentially compensated for,

and in that

The features are neither explicitly nor directly implicitly disclosed in the document of Mizuno.

Moreover, note that the functionality of the present invention that "the internal actuators are directly driven" should not be confused with the fact that according to the reference: "The horizontal dislocation amount acquired from the image date **taken in by a scanning image sensor 13** of an electron microscope 23" (Abstract, lines 4 to 6). The matter that the vibration for simplicity according to Mizuno "is taken in", i.e. acquired, "by scanning sensor 13", does not change the fact that in difference to the present invention according to claims 1, 22 and 36, Mizuno relies on indirect conventional vibration isolation and not on direct compensation.

Novelty and Inventive Step of Claims 22 over Masaki

For the amendments made with regard to independent claim 22, please see the new set of claims and note that the same arguments as brought forth in connection with claims 1 and 36 are valid for independent claim 22, too.

Therefore amended claim as well as claim 22 are also clearly not anticipated nor they had been obvious for a person skilled in the art at the time of Priority in the light of Masaki.

Wherefore, further consideration and allowance of the claims in this application is respectfully requested.

A three-month extension of time in which to response to the outstanding Office Action is hereby requested. PTO-2038 authorizing credit card payment for the amount of $460 is enclosed for the prescribed Small Entity three-month extension fee. Any other fee due by virtue of this filing or this application should be charged to Deposit Account 11-0665 . Any refunds in connection with this filing should be credited to Deposit Account 11-0665. A duplicate of this page is enclosed for this purpose.

Respectfully submitted,

M. Robert Kestenbaum

M. Robert Kestenbaum
Reg. No. 20,430
11011 Bermuda Dunes NE
Albuquerque, NM USA 87111
Telephone (505) 323-0771
Facsimile (505) 323-0865

I hereby certify this correspondence is being deposited with the U.S Postal Service as a first class mail in an envelope with adequate postage addresses to Commissioner for Patents, Washington, D.C. 20231 on February 13, 2002.

M. Robert Kestenbaum

A three-month extension of time in which to response to the outstanding Office Action is hereby requested. PTO-2038 authorizing credit card payment for the amount of $460 is enclosed for the prescribed Small Entity three-month extension fee. Any other fee due by virtue of this filing or this application should be charged to Deposit Account 11-0665 . Any refunds in connection with this filing should be credited to Deposit Account 11-0665. A duplicate of this page is enclosed for this purpose.

Respectfully submitted,

M. Robert Kestenbaum

M. Robert Kestenbaum
Reg. No. 20,430
11011 Bermuda Dunes NE
Albuquerque, NM USA 87111
Telephone (505) 323-0771
Facsimile (505) 323-0865

I hereby certify this correspondence is being deposited with the U.S Postal Service as a first class mail in an envelope with adequate postage addresses to Commissioner for Patents, Washington, D.C. 20231 on February 13, 2002.

M. Robert Kestenbaum

Figures 1a to 1d show different embodiments of the invention in the form of block diagrams,

Figure 2 schematically illustrates a scanning microscope according to the invention,

Figure 3 illustrates an exemplary reference object, of the kind that can be used for the calibration mode of the microscope in Figure 2,

Figure 4 shows an exemplary signal S of the image acquisition device when the microscope in Figure 2, in the calibration mode, scans and acquires a reference object on a predetermined path 9 in accordance with the coordinate x at different times,

Figure 5 shows the exemplary correlation between the displacement of the line centroids, which is illustrated by the curve 15, and the temporally corresponding profile 14 of an interfering quantity which is detected outside the apparatus and causes the displacement of the line centroids,

Figures 6a to 6c show the displacement of the image centroid of three successive images,

Figure 7 shows the temporal profile 17 of the displacement of the centroid from Figure 6 for the x-direction, and

Figure 8 shows an exemplary embodiment of an optical microscope corresponding to the block diagram of Figure 1c.

Figures 1a-1d schematically illustrate[s an] exemplary embodiments of the imaging and/or raster-mode scanning apparatus 1 according to the invention in the form of [a] scanning electron microscopes in [a] block diagrams. The

numeral 1 designates the apparatus without the compensation device for compensating for ambient influences which may degrade the imaging. The apparatus comprises a sensor 4 outside the apparatus, this sensor

4 outputting a first signal, which is dependent on the electromagnetic interference field at the location of the sensor, to a digital filter 5, the transfer characteristic of the filter 5 being set manually. The interference U affects both the sensor 5 and the apparatus 1, this being indicated, in this figure and also in Figures 1b to 1d, by the arrows proceeding from U. Having passed through the filter 5 and having been amplified in a regulating amplifier 6, connected downstream, the signal is applied to the electron beam deflection coils [(3)] of the scanning electron microscope. <u>The first signal which is dependent on the ambient influences and is applied to the signal input of the filter 5 can either be output by a sensor 4 for detecting at least one physical quantity outside the apparatus 1 (Figures 1a to 1c), or an output of the image processing device 2 is connected to the calibration input of the filter 5 (Figure 1d), with the result that the calibration signal depends on an image analysis, for example.</u> The regulating amplifier 6 serves for matching the output signal of the filter 5 to the actuator and/or to the control element 3. In detail, then, a compensation signal, that is to say a signal which is dependent on the interfering quantity, that is to say the electromagnetic interference field, is applied to the actual driving signal of the deflection coils 3. The arrangement of the sensor 4 outside the apparatus should be understood, according to the invention, such that the sensor 4 is arranged in such a way that the driving of the actuator and/or of the control element 3 does not significantly influence the measurement signal of the sensor 4. The effect achieved by the calibration of the filter 5 is that the applied compensation signal for the image acquisition corresponds precisely to an opposite effect which is caused by the electromagnetic interference field at the location of the apparatus 1 and,

consequently, the effect of the compensation signal application and the effect of the interfering electromagnetic field on the imaging essentially cancel each other out. If the scanning electron microscope 1 is moved to a different site, the filter 5 must be recalibrated in each case for the purpose of modelling the transfer function.

Figure 1b shows a block diagram of an apparatus 1 according to the invention, in which the calibration of the filter 5 and thus the calibration of the apparatus 1 are carried out by means of a second signal from an image processing device 2 which is included in the image acquisition device [2] 7 or is connected thereto.

Figure 2 corresponding to the block diagram of Figure 1b shows an apparatus of this type with the image processing device 2 being connected to the calibration input of the filter 5 in the case of a scanning electron microscope. The image acquisition device 7 acquires at least one pixel of the object and supplies the image processing device 2. As in the case of the first embodiment, the signal of the sensor is fed forwards to the deflection coils 3a, 3b. A signal for driving the calibration input of the filter 5 is generated in the image processing device 2. The calibration of the filter 5 and thus of the apparatus 1 is described below with reference to two different embodiments.

According to a first embodiment, the microscope 1 is set up for operation in a calibration mode and an image mode, whereby, in the calibration mode, ambient influences that reduce the imaging quality can be detected by the imaging of a predetermined reference object and comparison of the image with the real structure of the reference object, and can be essentially eliminated by calibration of the microscope 1, and the imaging defects are greatly reduced or essentially compensated for, even in the event of a change in the ambient influences, by maintaining the calibration in the image mode. Depending on the operating mode, the input signal of the calibration input of the filter 5 either depends on the respective measured imaging defect (calibration mode) or is obtained by means of the data stored during the

calibration mode (image mode). It is possible to switch back and forth between the calibration and image modes.

The calibration mode is utilized in order to detect ambient influences, that is to say in this case the electromagnetic interference field which reduces the imaging quality, by the imaging of a predetermined section of a reference object and comparison of the image with the real structure of the reference object, and to calibrate the apparatus in such a way that systematic imaging defects caused by external ambient conditions and/or caused by instrumentation are essentially compensated for. According to the invention, this calibration of the microscope 1 is carried out by setting the transfer characteristic of the filter 5. Figure 3 illustrates how the scanning device scans a selected section of a reference object in the calibration mode, in which case, in the digital image processing device 2, a stored signal assigned to the reference object is compared with the image signal of the reference object that is obtained from the image acquisition device 7, and a signal assigned to the difference is formed and is output to the calibration input of the filter 5.

The calibration method in the calibration mode can be described by the following steps:

- determination of a first signal, which depends on the electromagnetic interference field at the location of the sensor, by a sensor 4;
- application of the first signal to the signal input of the filter 5;
- acquisition of a selected section of a predetermined reference object by means of an image acquisition device 7 by scanning the reference object;
- comparison of the acquired image with the real structure of the reference object;

- determination of a defect signal assigned to the difference;
- application of the second signal, derived from the defect signal, to the regulating input of the filter 5 for defining the transfer characteristic of the said filter;
- application of the output signal of the filter 5 to the signal input of the regulating amplifier 6;
- application of the output signal of the regulating amplifier 6 to the electron beam detection coils 3a, 3b (Figure 2) for the purpose of correcting the reduced image quality;
- iterative calibration of the characteristic of the filter 5, in such a way that the reduction of the imaging quality is greatly reduced or essentially compensated for, by means of the following steps:
- comparison of the corrected image with the real structure of the reference object
- alteration of the transfer characteristic of the filter 5 in such a way that the corrected image approximates to the real structure of the reference object;
- storage of data for generating the determined transfer function of the filter 5 for the image mode.

In one embodiment, these data for generating the determined transfer function of the filter 5 for the image mode are stored in a memory assigned to the image processing device 2. In a further embodiment, the filter 5 is set up for storing these data. While the imaging defect is being determined, the devices for compensating for the imaging defects are switched off. The microscope 1 according to the invention is then calibrated by the method described above, that is to say the feedforward for the measurement signal of the sensor is set as a measure of the interfering quantity.

The compensation quality is measured by repeated scanning of the reference object and comparison of the image with the real structure of the reference object. By determining the compensation quality in each case and correspondingly changing the transfer function of the filter, the feedforward is iteratively changed in such a way that the imaging defects of the scanning electron microscope are minimized.

The microscope 1 can be calibrated with regard to location- and/or time-variable imaging defects.

For this purpose, a reference object as shown in an exemplary fashion in Figure 3 is scanned on a predetermined path in the calibration mode. The imaged reference object comprises circular gold deposits which have been deposited on a substrate and are arranged in a predetermined manner. The scanning device of the microscope is driven externally, with the result that a selected section of the reference object is acquired. This path may, for example, be closed like that shown by the curve 9. Individual objects 8 are situated on this closed path, to which objects the image acquisition device 2 responds and generates a signal not equal to zero. This is shown schematically and by way of example in Figure 4, which illustrates the signal profile 10 acquired at a given instant t_i during the traversal of the closed curve 9. Time-dependent interference can cause time-dependent imaging defects. For this reason, in the illustration of Figure 4, the closed curve has been traversed four times at intervals. The resulting four signal profiles 10 are thus also a measure of the temporal dependence of the interference. Furthermore, the traversed curve is altered by varying the radius R, whereby location-dependent imaging defects can be detected. According to the invention, the time- and/or location-dependent imaging defects are determined by comparison of the

image in the image processing device 2 with the predetermined reference object, which is known exactly. In the example represented in Figure 4, the time-dependent imaging defect is illustrated by the curve 11.

The image mode is the operating mode of the inventive scanning electron microscope 1 in which the actual sample is measured. The filter 5 transfer characteristic determined in the calibration mode is invariant during the subsequent image mode with regard to the characteristic defined in the calibration mode. As explained above, however, it can vary with respect to time and as a function of the scanning location.

Assuming an essentially constant correlation between the electromagnetic interference field and the imaging defect caused by this interfering quantity, the output signal of the filter 5, after passing through the regulating amplifier 6, is applied to the electron beam deflection unit 3, with the result that image defects are essentially compensated for even in the event of a change in the ambient influences, that is to say the strength of the electromagnetic interference field.

In an embodiment developed further, in addition to the electromagnetic interference fields, air vibrations and/or ground vibrations are also detected by corresponding sensors 4, the signals that are output pass through calibratable filters 5 which are assigned to the respective instances of interference and have adjustable transfer characteristics, and, after additional matching in the regulating amplifier 6, are applied to the deflection unit as a further control signal and/or to other actuators, with the result that the imaging defects caused by air vibrations and/or ground vibrations are also greatly reduced or essentially compensated for.

The necessity of having to switch back and forth between different operating modes of the apparatus is overcome in the embodiment described below by virtue of the fact that the apparatus is set up for automatic calibration of the filter during the image mode. In order to simplify the explanation, this embodiment is again described with regard to a scanning electron microscope, but is not restricted thereto. The apparatus essentially comprises the components of the scanning electron microscope described above, with the exception that in the image processing device 2 the acquired image is analysed and a signal dependent on the analysis is applied as second signal to the calibration input of the filter 5. In the exemplary embodiment, this image analysis comprises the recursive determination of the displacement of the line centroids of successive image lines within the whole image. The analysis is based on the insight that images of objects in imaging and/or scanning apparatuses 1 are generally not stable with respect to time on account of the influence of the interfering quantities of the imaging. For elucidation purposes, Figure 5 illustrates the profile of the brightness within four selected image lines, the centroids of the brightness distribution in each line being identified by a circle and the curve 15 illustrating the displacement of this centroid of the chronologically successively scanned lines. In a manner corresponding to the respective line acquisition instants, the magnitude of an exemplary interfering quantity which causes the corresponding pixel displacement of the centroid within the lines is plotted as curve 14 on the left-hand side. In this way, it is possible to produce a correlation between the interfering quantity and the imaging defect caused by this interfering quantity. The pixel displacement of the line centroid from one image line to the next

serves as the amplitude of the image interference. The line frequency permits an assignment of time and frequency for the correlation in the case of the active compensation signal application of the feedforward signal. If the external sensor as shown in Figure 1c arrow from 3 to 2 is read in in parallel with the determination of this pixel displacement at the beginning of each line, a time-parallel or simultaneous detection of the image interference and of the interfering influence that causes this interference can be performed. In principle, assuming sufficient coherence, it is thus possible to directly calculate the transfer function to be set at the filter 5 in order to essentially compensate for the image interference. In an alternative embodiment, fundamental assumptions are made concerning the poles and zeros of the transfer function of the filter, and the individual parameters of the variably configured functions are optimized iteratively.

An exemplary method for determining the centroid displacement of successive lines is briefly outlined below. On the basis of the sampling theorem, it is possible to compensate for interference frequencies which are less than half the sampling frequency. Furthermore, the method presupposes that individual objects within the image are very much larger than the line spacing and that centroid displacements perpendicular to the scanning direction in the image are small in comparison with centroid displacements parallel to the line direction. Moreover, it is assumed that the difference in the intensity ε_n (t) of neighbouring lines is small, and the intensity f_{n+1} of the line n+1 can be written as follows:

$$f_{n+1}(t) = f_n(t) + \varepsilon_n(t).$$

If this system is then interfered with, assuming that the

interference causes a temporal displacement Δ_n of

effect on the image in the latter. In Figure 8, the filter, the amplifier and the control element are not explicitly shown but rather are contained integrally in the image processing device 21. According to the invention, then, in this apparatus a compensation signal is not applied to an actuator which influences the imaging, rather, instead of this, the image display 22 is influenced directly. The camera system comprises a CCD camera 19 with a monitor, an image frequency of 25 Hz being worked with. The image processing device 21 is set up for storing successive images. By means of image analysis, the displacement of the image centroid of successive images in two mutually orthogonal directions is calculated and used to set the transfer function of the digital filter 5 in a similar manner to that in the embodiment described above. An illustrative representation of this displacement of the centroid of successive images 16 is shown in Figures 6 and 7. The curve 17 in Figure 7 shows the profile of the coordinate x of the centroid with time. The differences between two scanning points, for example t_0 and t_1, thus correspond to the image refresh frequency.

A further embodiment, in comparison with the embodiment described above, enables instances of interference to be corrected by the compensation signal application even at frequencies which are greater than the image refresh frequency of 25 Hz. For this purpose, the transfer function, which is defined by the points of resonance in the mechanical construction of the microscope, is implemented as the filter 5. In this way, a base vibration X generates a relative movement Δx at the microscope. The general transfer function is thus completely determined by the actual sensitivity $\Delta x/X$, the resonant frequency f_R and by the parameter Q, which defines the asymptotic decline of $\Delta x/X$ at high frequencies.

By determining three points on the curve

below the resonant frequency f_R as well, it is thus possible to infer the entire function and use it in the feedforward control by application of a compensation signal also for interference frequencies which are greater than the image refresh frequency.

In contrast to the embodiments described heretofore, according to the invention it is possible, moreover, to use the image information not in feedforward arrangement but in a traditional feedback arrangement for the compensation of image interference. This is illustrated schematically in the block diagram of Figure 1d. The sensor whose signal is fed forwards is omitted, and instead of this the centroid displacements determined in the x- and/or y- axis from the image analysis are fed back into a suitable control element, in this case a device for displacing the sample, after passing through an adjustable transfer function.

In further embodiments (not illustrated in any detail here) of the invention, the apparatus may be a force microscope, a surface roughness measuring instrument, an optical scanning microscope or a lithography installation.

Depending on the embodiment, in the case of electron microscopes, the driven actuators and control elements comprise the already described electron beam deflection devices and/or control elements in the image processing device, and in the case of optically operating apparatuses, the actuators comprise, depending on the embodiment, devices for deflecting the light and/or devices for deflecting the sample and/or control elements in the image processing device. A control element in the image processing device in this case designates, by way of example, the influence on a parameter which has effects on the calculation of the image. Moreover, use is made of further actuators which are sensitive to vibrations, and also force actuators